



# Final Report

## Rural PNPM Institutional Strengthening for Renewable Energy (ISRE 2014)

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## Abbreviations

BoQ	Bill of Quantities
DED	Detailed Engineering Design
DLC	Digital Load Control
ELC	Electronic Load Control
FK	<i>Fasilitator Kecamatan</i> (Sub-district Facilitator)
FT	<i>Fasilitator Teknik</i> (Technical Facilitator)
MHP	Micro Hydropower Plant
NGO	Non Government Organization
PNPM-MP	<i>Program Nasional Pemberdayaan Masyarakat Mandiri Perdesaan</i> (National Program for Community Empowerment for Rural Areas)
PNPM-LMP	<i>Program Nasional Pemberdayaan Masyarakat Lingkungan Mandiri Perdesaan</i> , (National Program of Community Empowerment – Rural Self-Sustaining Environmental, 'Green PNPM')
PUE	Productive Use of Energy
TOT	Training of Trainers
TSU	Technical Support Unit
VMT	Village Management Team

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## 1. INTRODUCTION

Rural PNPM Institutional Strengthening for Renewable Energy (ISRE) was implemented in collaboration with Regional Management Consultants (RMC) V (five/5) of Rural PNPM for the region of West and South Sulawesi. During project implementation, 82 micro-hydro power plants (MHPs) have received Mini-grid Service Package (MSP) which consisted of four (4) project activities, namely technical review, Village Management Team (VMT) training, TOT or facilitators training, and KPI survey and technical inspection. This project was implemented for six months, from February to August 2014.



A Power house of MHP comprises turbine, generator, and ELC

Ideas for project development came from the experience of Endeavour Indonesia in supporting Green PNPM, sister pilot program under Rural PNPM, through the establishment of the Technical Support Unit (TSU). The Unit has supported more than 150 MHP sites and based on a study on sustainability titled *Micro Hydro Power (MHP) Return of Investment and Cost Effectiveness Analysis* (World Bank Group, 2012) done by Castlerock Consulting, it was revealed that sites with TSU support have better quality in technical performance. Also, most TSU-supported sites have less technical problems and better community skill in monitoring and managing revenues and expenses of MHP as well as the daily operation of MHP. The study result provides a good basis to develop ISRE Program and encourage Rural PNPM Authority to apply the same mechanism.

This report summarises the activities, indicators reached and key experiences gained from ISRE.

## 2. OBJECTIVE

The Endeavour Indonesia ISRE initiative had the following objectives:

1. Transferring TSU's knowledge and working mechanism within Rural PNPM.
2. Strengthening knowledge and skill of Rural PNPM Facilitators in the field of minigrid MHP development
3. Providing technical inputs to improve the quality of MHP which is built through Rural PNPM Fund in the future
4. Building the capacity of MHP VMTs to manage, operate, and maintain the facility independently



Civil Construction of an MHP comprises Weir, channel, and forebay

### 3. DESCRIPTION OF ACTIVITIES under RURAL PNPM ISRE

The tables below provide an overview of the activities conducted under ISRE:

Table 1 Description of Activities

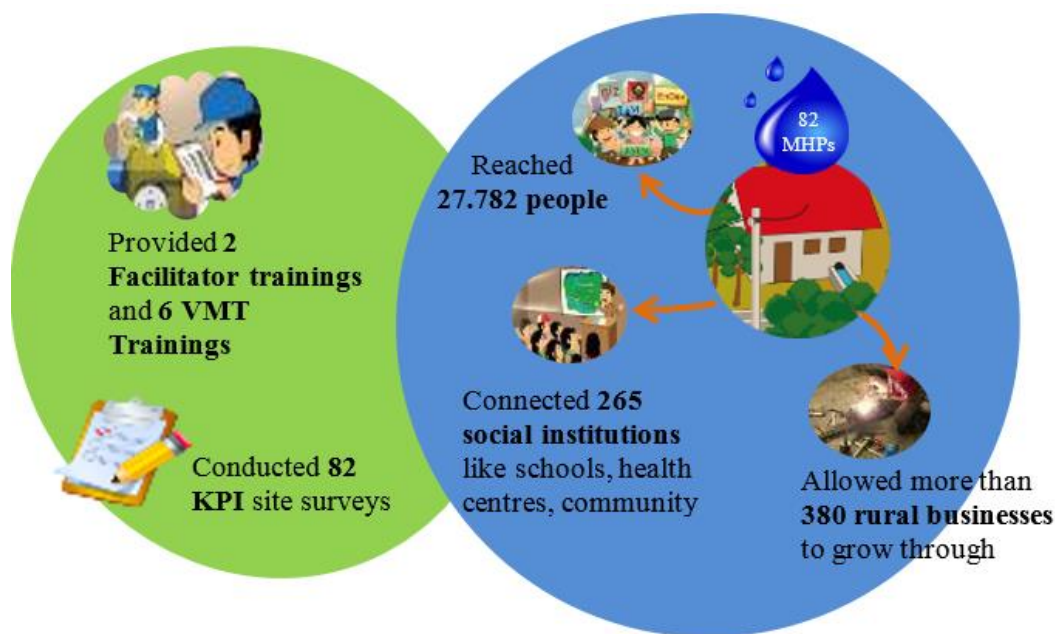
TECHNICAL SUPPORT	
Technical Review procedure	Output: <ul style="list-style-type: none"> <li>Site code provided</li> <li>Inspection report (Technical review report)</li> </ul>
CAPACITY DEVELOPMENT	
<b>Facilitator Training</b> Participants: Rural PNPM Technical Facilitators and Facilitators for Community Empowerment	
5 – day training on Technical aspects of MHP, including introduction to MHP Operation, site assessment, DED and BoQ Calculation, MHP maintenance, Mechanical and electrical commissioning procedure	Output/outcome: <ul style="list-style-type: none"> <li>Technical Facilitator Training conducted</li> <li>Facilitators are able to assess new sites and perform commissioning</li> <li>Facilitators able to conduct VMT Training in their respective villages/sub-Districts</li> </ul>
<b>VMT training</b> Participants: VMT Members	
4-day training programmes on MHP operation and maintenance, Administration, tariff setting, village regulation, and PUE	Output/outcome: <ul style="list-style-type: none"> <li>VMT training conducted</li> <li>VMT is able to manage, operate, and maintain MHP facility independently</li> </ul>
SUSTAINABILITY MONITORING	
KPI survey and SMS-Gateway (BReIDGE) for monitoring and feed-back	Output/outcome: <ul style="list-style-type: none"> <li>Monitoring information materials distributed</li> <li>BReIDGE records</li> </ul>



## 4. ACHIEVEMENT OF ENDEV ID INDICATORS

The pictogram below shows the key indicators reached under ISRE:

Figure 1 Pictogram of Indicators



## 5. SITE DISTRIBUTION and GENERAL PROFILE

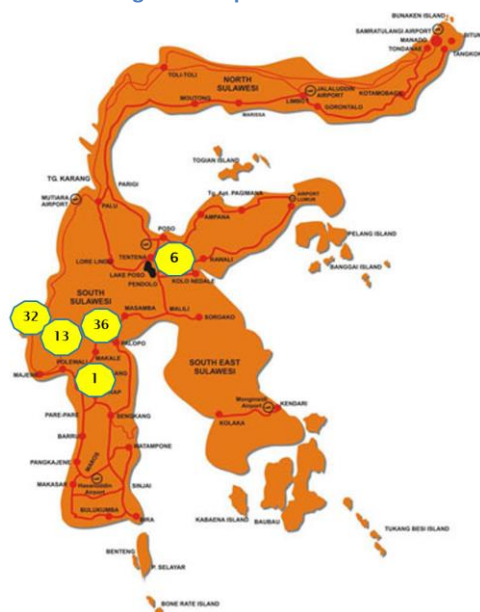
Under ISRE, 82 MHP sites were supported, which consisted of 43 sites in South Sulawesi and 39 sites in West Sulawesi. Of these 82 sites, 2 sites were established by Ministry of Cooperative in 2013/14.

Total generation capacity for the supported sites was 409.4 kW, with the smallest capacity being 1.3 kW and the largest 27.3 kW.

The farthest site is 183 km from the closest city and could only be reached by motorcycle while the nearest site is only 3 km away.

Most people who connected to the MHP work as farmers, as the sites are very good for farming or small plantation, i.e. coffee and cacao.

Figure 2 Map of ISRE Sites

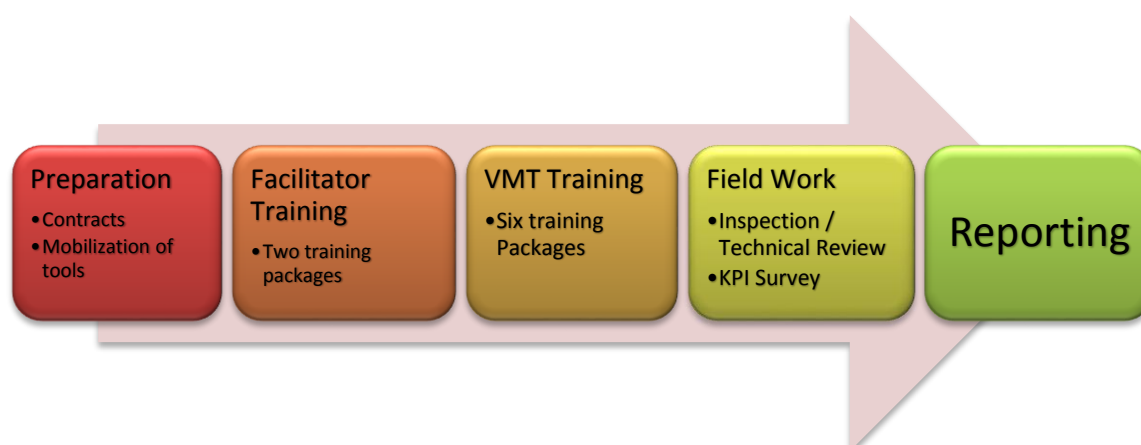


## 6. IMPLEMENTATION PROCESS

ISRE was implemented over a 7 month period. A team of five (5) local consultants were hired for implementing the project, consisting of one Coordinator, one Assistant Coordinator and three technical team members.

The implementation started on March 10, 2014 with Facilitator and VMT Training in South Sulawesi, then continued with field surveys on the second week of March 2014. All work in South Sulawesi was completed in the first week of May 2014. After South Sulawesi, the team moved to West Sulawesi and did the first training in 18 May 2014. After all field was surveyed, the works completed in 31 August 2014.

Figure 3 Implementation Process



### 6.1 Capacity Building

#### 6.1.1 The Process

Eight (8) Training packages were conducted in South and West Sulawesi, which consisted of two Facilitator trainings and six VMT Trainings.

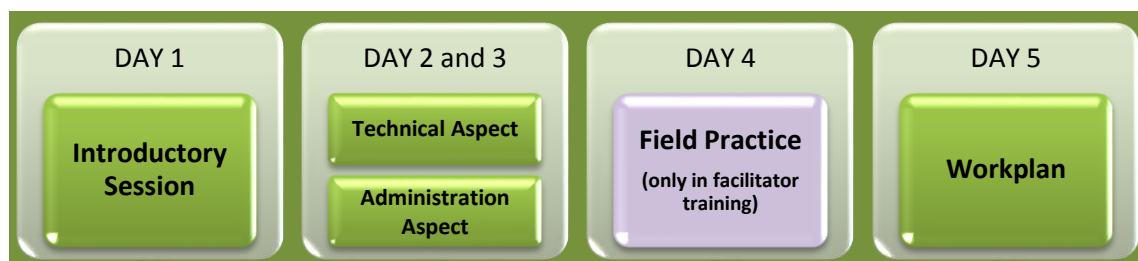
Each facilitator training was conducted for five days, with four day classroom and one day field visit while VMT training was conducted for four days, without field visit. Below is training implementation table:

Table 2 Training Implementation

<b>Package 1</b>	TOT Training	South Sulawesi	Rantepao, Tana Toraja	10-14 Mar 2014	38 trainees
<b>Package 2</b>	TOT Training	West Sulawesi	Mamuju, Mamuju	19-23 May 2014	42 trainees
<b>Package 3</b>	VMT Training	South Sulawesi	Rantepao, Tana Toraja	17-20 Mar 2014	56 trainees
<b>Package 4</b>	VMT Training	South Sulawesi	Rantepao, Tana Toraja	20-24 Mar 2014	52 trainees
<b>Package 5</b>	VMT Training	South Sulawesi	Palopo, Luwu Utara	14-17 Mar 2014	18 trainees
<b>Package 6</b>	VMT Training	West Sulawesi	Mamuju, Mamuju	26-29 May 2014	34 trainees
<b>Package 7</b>	VMT Training	West Sulawesi	Mamuju, Mamuju	02-05 Jun 2014	39 trainees
<b>Package 8</b>	VMT Training	West Sulawesi	Mamuju, Mamuju	05-09 Jun 2014	43 trainees

The training started with introduction to MHP operation, management and maintenance. On the second and third day, it divided into two parallel sessions. At the end of training session, the class united again to discuss work plan and next activities.

Figure 4 Pictogram of Training process



### 6.1.2 Training Materials and Trainers

Training materials for the two training type was almost similar. The differences laid in the site and project preparation, commissioning, and field trip. In Facilitator Training, all those topics were presented, but not in the VMT Training.

Table 3 List of Training Materials

TRAINING MATERIALS		TOT TRAINING	VMT TRAINING
<b>A. INTRODUCTION</b>			
1	Introduction to MHP Principles and sustainable Utilization	✓	✓
2	Introduction to VMT	✓	✓
3	Environmental Management for MHP sustainability	✓	✓
4	PUE and Business development	✓	✓
5	Sustainability Monitoring: KPI Survey and Breidge	✓	✓
<b>B. TECHNICAL ASPECTS</b>			
1	Technical workshop	✓	✓
2	Site Survey/Site Verification	✓	
3	DED and BoQ Development	✓	
4	Stakeout	✓	
5	Commissioning	✓	
6	MHP Maintenance	✓	
<b>C. ADMINISTRATION AND MANAGEMENT ASPECTS</b>			
1	Introduction to VMT	✓	✓
2	Tariff Setting	✓	✓
3	Financial Management	✓	✓
4	Administrative and Management Aspects	✓	✓
5	Legal Aspect of VMT and Cooperative establishment	✓	✓
<b>FIELD TRIP</b>		✓	

Five (5) videos were also presented during training sessions. The videos related to MHP working scheme; maintenance and operation of MHP; administration and management of VMT; and Introduction to PUE.

Total 17 trainers involved in all training package. Some trainers came from Rural PNPM and Local NGOs/Cooperative, as can be seen in the below table:



Table 4 List of Trainers

			Introduction	Technical Aspects	Administration & Management	Package							
						1	2	3	4	5	6	7	8
1	Arman Abu, ST	ISRE Team	*		*								
2	Ir. Muhindar	ISRE Team			*								
3	Ir. Ferdinandus BT	ISRE Team	*	*									
4	Munawir, ST	ISRE Team		*									
5	Alamsyah, ST, MT	ISRE Team	*		*								
6	Marthen Rambung	Government Official			*								
7	Jufri Manga, ST	Rural PNPM			*								
8	M. Iqbal ST	Rural PNPM		*									
9	Yesaya Famay	Local NGO	*										
10	Yusuf Sampe Alik	Local Cooperative			*								
11	Amil Sudir Ambara	Rural PNPM		*									
12	Syahrum ST	Green PNPM	*		*								
13	Haltin Singkang, ST	Rural PNPM			*								
14	Muklis	Local NGO	*										
15	Supriyadi Yusuf	Rural PNPM	*										
16	Rahmiati A. Tamma	Rural PNPM			*								
17	Farida Hamra, SP	Rural PNPM	*		*								
18	Abd. Rahman SE	Rural PNPM			*								

### 6.1.3 Participants

Total 326 persons participated in 8 training packages; 80 of them were Rural PNPM Facilitators working in West and South Sulawesi, and 246 person were VMT members from 82 MHP sites.

Table 5 Number of Participants

▪ Technical Facilitators (FT)	44 persons
▪ Facilitator for Community Empowerment (FK)	18 persons
▪ District Facilitator (Faskab)	4 persons
▪ Technical Facilitator at District Level (Fastekab)	6 persons
▪ Assistant of Fastekab	1 persons
▪ Local Facilitator/Assistant (PL)	2 persons
▪ Community cadres (Kader)	5 persons
MHP VMT Members:	
▪ Head of VMT	82 persons
▪ Operator	83 persons
▪ Treasurer/Administrator	81 persons

During VMT Training, five (5) VMTs from Mamuju and Mamasa could not participate, but they were trained on-sites during KPI survey.

### 6.1.4 Training Quality

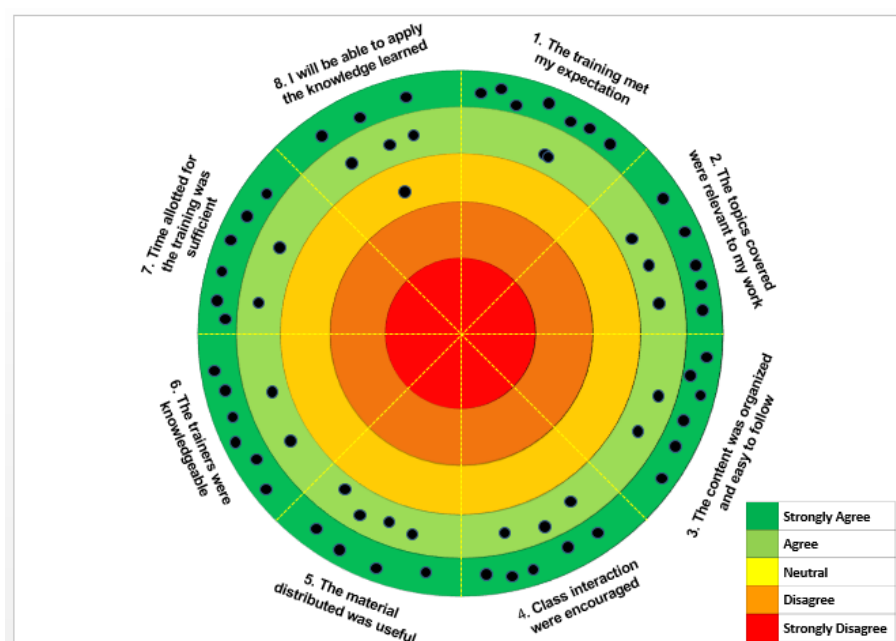
The result of Pre and Post Test indicated that there was significant knowledge improvement in VMT participants compared to that of facilitator participants (package 1 and 2). This is because almost all of PNPM Facilitators were university graduates, thus they already possessed basic knowledge and skills relevant to the subject, while for VMT members who come from the local community, this is a new skill.

Pre and Post Test for Facilitator Training (package 1 and 2) consist of 19 questions and divided into general questions related to MHP, technical questions (for Technical Facilitator) and management related questions (for Community Development Facilitators)

Meanwhile for VMT training, the test consisted of 30 questions divided into 3 parts: general questions, technical aspects and managerial aspects

By the end of each packages, all participants was invited to do an evaluation on training implementation and the result could be seen in the evaluation wheel:

Figure 6 The Evaluation Wheel

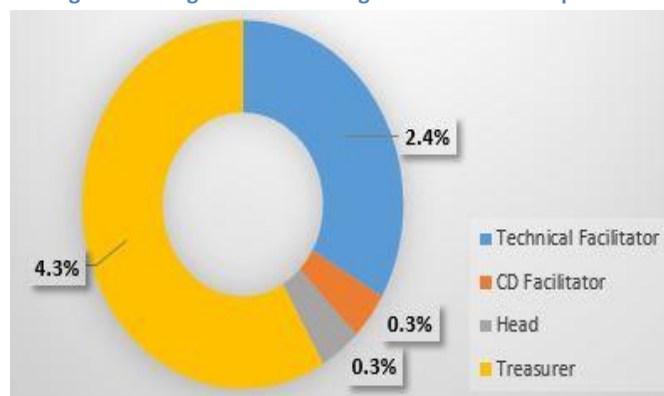


### 6.1.5 Women Participation

The participation of women in the training was not high. Only 24 women out of 328 participants were participated in 8 training sessions.

Looking at the type of work, most of these women were working as treasurer. While this is a typical women's position in an organization such as VMT, it is also one of the most critical, as it keeps track of financial resources. The second rank is occupied by women who work as a Rural PNPM technical facilitator. Even though the percentage was still low, the involvement of women as technical facilitators increased from time to time.

Figure 7 Pictogram of Percentage of Women Participation



## 6.2 Technical Review and KPI Survey

### 6.2.1 Purpose and Approach

Technical Review was done to ensure that all MHP systems and components constructed and installed in accordance with the design, operational requirements and specifications that have been determined. The Key Performance Indicator (KPI) survey was carried out to collect base line data related to social and economic of target beneficiaries as well as management scheme of MHP. In technical review three aspect were reviewed, they were component compliance, performance verification, and workmanship.

Technical review and KPI survey for 82 sites (43 sites in South Sulawesi and 39 sites in West Sulawesi) carried out by the consulting team over 70 days. At every site, the consultant spent 2 to 3 days to check and test the MHP components as well as gather KPI data.

Steps of technical review is outlined as follow:

Figure 8 Steps of Technical Review



### 6.2.2 Result

Data gathered during the survey were assessed in a summary sheet. During assessment, some handicaps were found, among other was the absent of Detailed Engineering Design (DED) and relevant technical information, as basis for review. Therefore, the conclusion of Technical Review was drawn based on basic requirement of MHP scheme.

A good MHP design comprises of weir, intake, channel, spillway, forebay (and trash rack), penstock, power house, distribution network components. Those component need to be designed and measured properly in order to reach the design capacity. Thus besides water debit and head, a good and reliable system is also vital to MHP operation.

Figure 9 MHP Components



All MHPs under ISRE were built by the community with facilitation from PNPM Facilitators, except for two sites which were built by contractors. The fund allocated for Rural PNPM MHPs was relatively low (IDR 350 Million) compared to that of Green PNPM (above IDR 500 Million). Therefore some components of the MHPs established under Rural PNPM were lacking or poorly installed.

#### A. Civil Construction

Three main components in civil construction that need to be improved were weir, intake and sluice gate. These components were poorly constructed or even missing in 49 sites. The main function of those components are to control water inflow and sediment/mud, as overflow will damage the channel system and sediment will harm penstock and turbine.





**SulBar117:** Intake without weir, and the whole body river was blocked by concrete wall



**SulBar111:** Better weir and intake



**SulSel240:** Weir made from formation of rocks, no proper intake construction and no intake gate



**SulSel 262** Permanent weir and intake

## **B. Mechanical and Electrical (M&E)**

Crossflow was type of turbine that commonly installed in ISRE sites. About 81 sites using this type and only one site using propellers because the head in that site is low. As for generator, 64 sites were using synchronous generator which is better than asynchronous generator, in terms of producing electricity, but the price is relatively high and spare part is difficult to find in small cities.

The condition of most M&E were poor and no proper safety cage was installed to protect operators from accident. The main problem found in ISRE MHPs was leaking, broken guide vane, bearing and un-fastened V belt.





**SulSel253:** No safety cage, not painted, and hot bearing



**SulSel242:** Safety cage made from wood



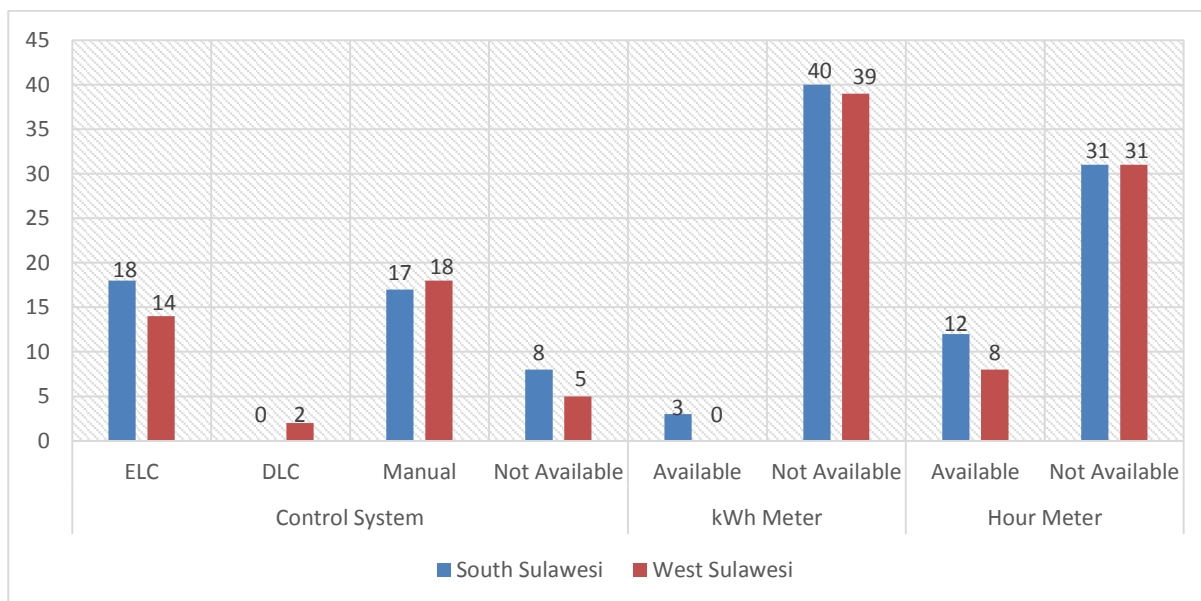
**SulBar140:** Regulator lever not functioning well and turbine leaked



**SulBar113:** Good and clean M&E

Control panel, kWh meter, and hour meter are three components that are usually missing or not properly installed at Rural PNPM MHPs. Control panel is significant for ensuring the life-span of both MHP scheme and electrical equipment and appliances at beneficiaries houses, since it stabilize the load and frequency produced by MHP scheme. About 50% of control panels were operated manually and the rest were using ELC or DLC type. Meanwhile only 3 sites applied kWh meter and 20 sites installed Hour Meter. The kWh meter and hour meter are devices to measure electricity production and usage. The devices are important to calculate the tariff, but during ISRE, most site applied flat tariff. Below is the installation status of the three components:

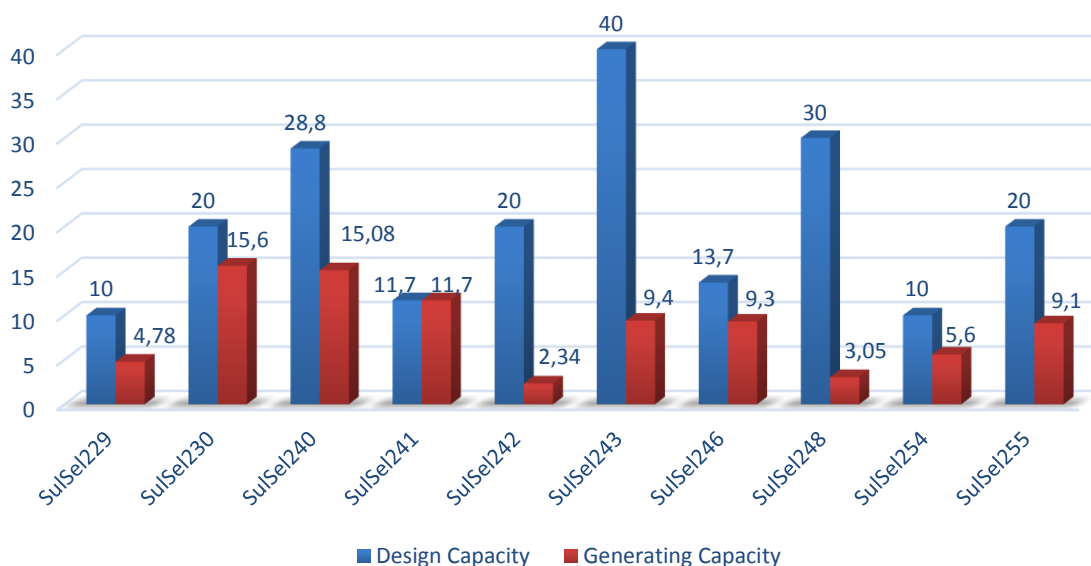
Figure 10 Installation Status

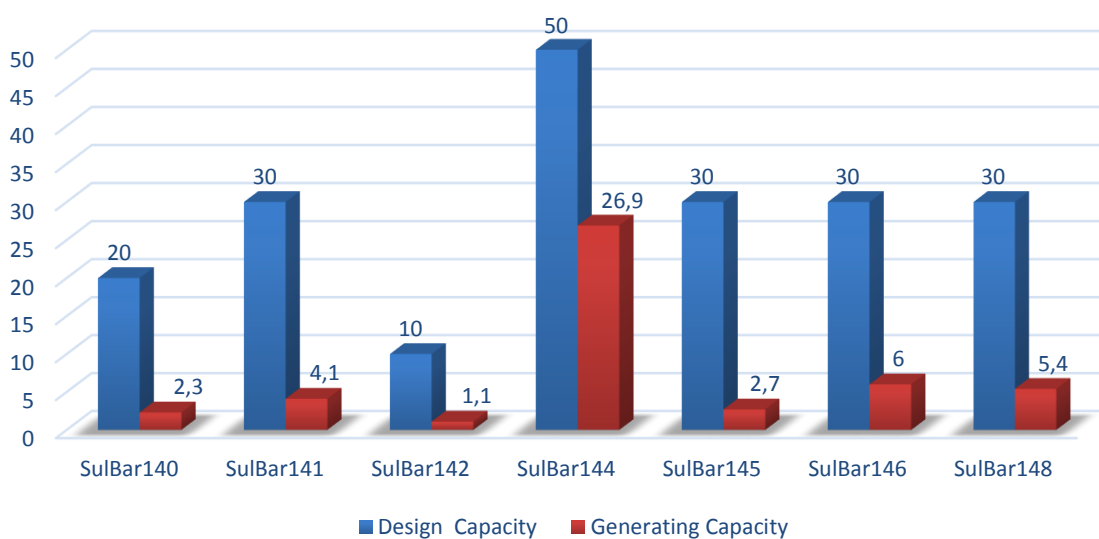
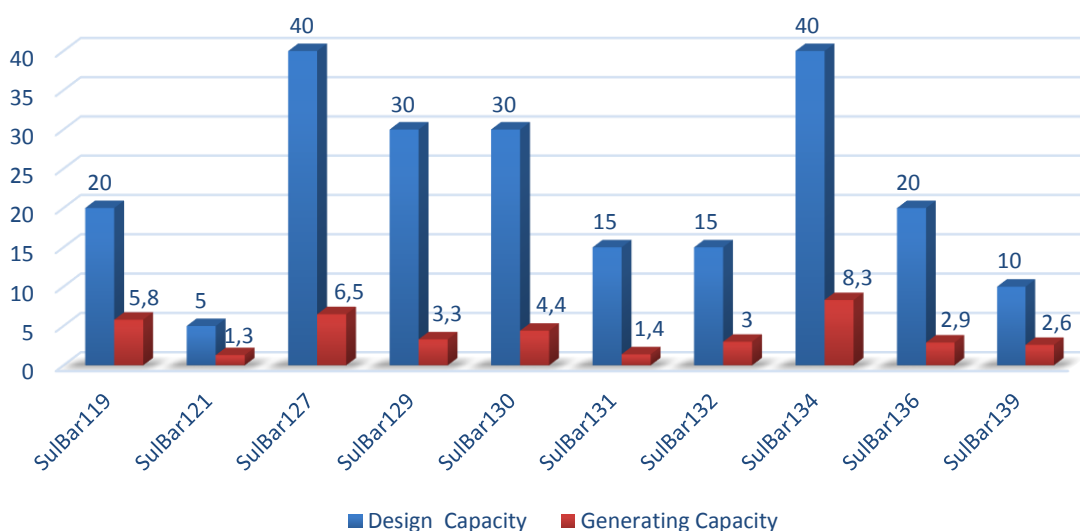
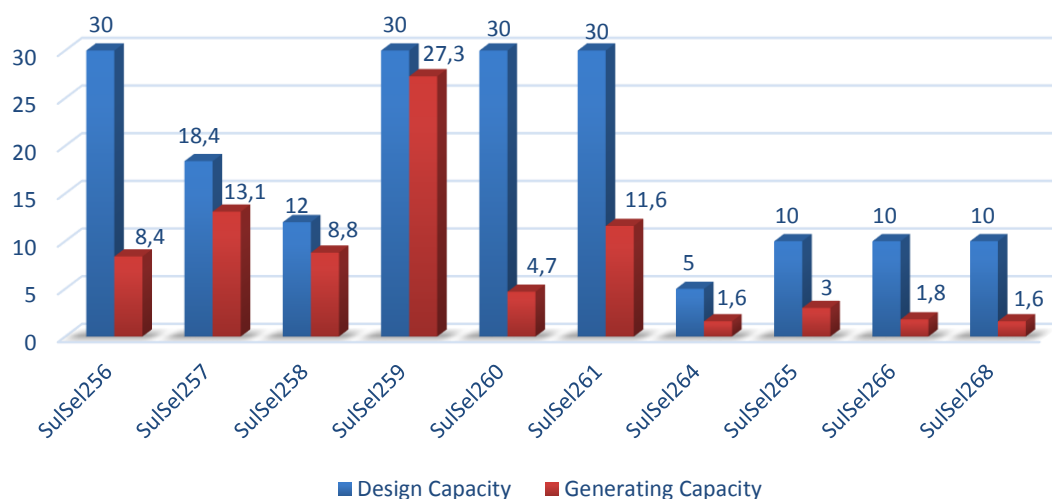


### C. Capacity Installed

In terms of capacity, only 37 sites provided design capacity data, and the installed capacity of these sites were below the design capacity. Only one MHP in Puangbebe, Tana Toraja in South Sulawesi (SulSel241) was reached its design capacity (11.7kW). The low capacity was the result of poor construction and maintenance.

Figure 11 Design Capacity vs Generating Capacity





#### D. Distribution Network

Tree stem, logs or bamboo is the most common poles in Rural PNPM sites, because of the limited availability of funds to build utility-approved concrete poles.



**SulBar123:** Pole made of tree stem without proper accessory



**SulSel264:** Pole made of bamboo



**SulBar111:** Pole made of log

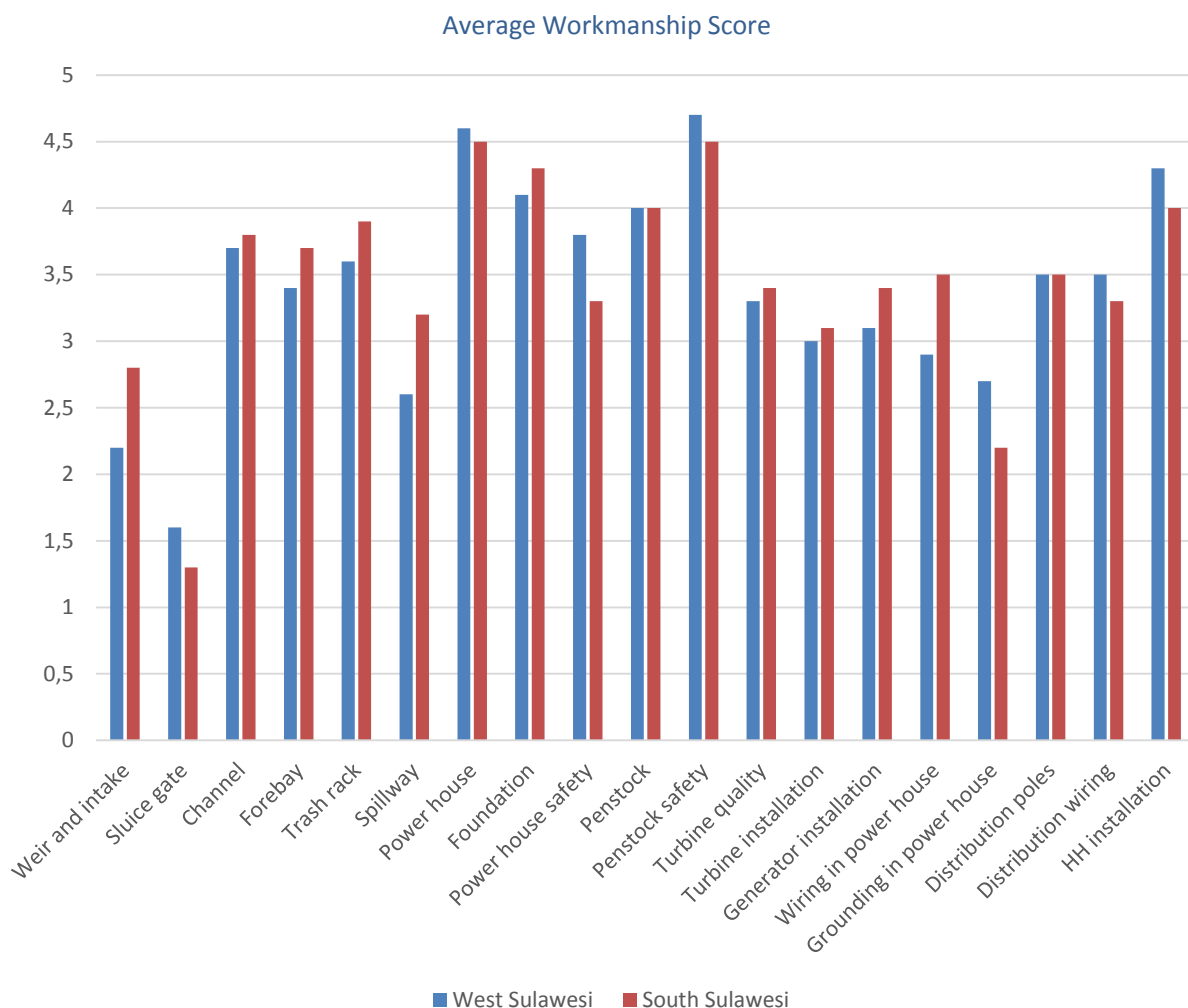


**SulSel243:** Pole made of concrete

## E. Workmanship Score

Looking at the score for each components, penstock safety reached the highest score, because most of the penstock were burried under ground. Meanwhile sluice gate in both West and south Sulawesi has the lowest score.

Figure 12 Workmanship Score





### 6.3 Lessons from the Field

Good communication is key to develop good collaboration with Rural PNPM Authority in West and South Sulawesi. During project implementation, the ISRE team made intensive communication with the authority and also invited Rural PNPM Consultants as trainers in the facilitator training. Other stakeholders that also approached by the team were NREEC agency and Cooperative agency and they also involved in the training.

The participation of stakeholders as trainers has enriched the content of training materials as well as the training process, since they contributed their field experiences. One main input from guest trainer was the training was too rigid and not sufficiently dynamic. They suggested to adopt adult education approach and apply more games and meta-plan to uncover participants' knowledge, especially for materials related to management (non-technical aspects).



Facilitator Training in Mamuju, West Sulawesi: involvement of stakeholders as trainers have enriched the training materials

In regard to VMT legal status, there is plan from Cooperative Agency in South Sulawesi to upgrade VMTs to cooperatives. At the moment, one VMT in Tana Toraja District was in the process of applying cooperative status, but unfortunately they have to postpone it since the money for paying the registration fee is not collected, yet. This VMT was assisted by Bapak Yusuf Alik, the Director of Pemuda Prima Lestari Coop as well ISRE guest trainer for Package 3 and 4. Beside this VMT, two other VMTs are also applying for cooperative status

Assessing Rural PNPM MHP was very challenging. Not only because many supporting data was not available, but also fund limitation has resulted in the variation of MHP quality. Missing specification labels on some of the equipment also proved a hinderance, since it prevented comparison between design and actual performance.

Another problem related to the quality of MHP is the availability of adequate survey equipment. According to Rural PNPM Facilitators, they did not have the proper equipment to undertake feasibility study or commissioning. Therefore they often relied heavily on the assumptions or inputs from local community when gathering data for designing the MHP.

EnDev Indonesia is a proud project under  
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